Dynamic 3D Nip Impulse Measurement

3D nip impulse measurement enables real-time insight of nip conditions

Xerium Technologies Inc., Youngsville/US with its subsidiary Stowe Woodward AG, Heidenheim/Germany, a global market leader in roll covers and spreader rolls, has taken a further development step in the area of nip analysis. With Smart® 5.0, papermakers are now in the position to observe the press nip performance in real time and under dynamic production conditions. With the assistance of the combined display of nip load, nip impulse and nip width, the paper machine is able to operate at the peak performance range. The UPM Schongau PM6 field study, where the new nip profiling technology was introduced in EMEA, shows how efficiently the optimized press nip performance can affect the overall productivity.

One of the key factors for improving paper machine efficiency is a press section with optimally controlled nip conditions. In this area, uniform nip profiles provide for the highest level of performance. Therefore, their continuous monitoring and measurement is crucial for the performance of the machine.

Smart® Roll – pioneer in nip profiling technology

In the area of nip profiling technology, Xerium has always been a pioneer, and sets standards with innovative measurement processes. Following on from pressure-sensitive films, which were used in the 1980's, Xerium developed the first patented and computer-supported nip profiler application in the 1990's. From the measurement result, the optimization potential could be elaborated and the nip proportions could be improved. *Fig. 1* shows the development cycle of the applied nip profiler technologies in chronological order.

For a long period nip profiling was a static measurement process; this means it required machine downtime (including PMC or RC changes). Even though the nip profiler technology was able to create measurable advantages through optimal alignment of nip geometry the associated negative effects (machine downtime and loss of production) were all too noticeable.

The aim was to develop a method for pressure control or nip analysis that could also be used during on-going production. In 2008, this innovation process led to the development of the Smart® Roll, the world's first press roll which is able to measure and monitor the pressure in the nip even during operation – a patented, pioneering achievement that Xerium has developed for nip analysis at widely varying positions in the paper machine.

Optimal nip conditions

With Smart® 5.0, Xerium breaks another barrier in the area of online sensor technology. For the first time, a sensor system embedded in the functional covering of the roll cover, provides online measurement of the nip width in correlation to the nip load, in real time and under full running dynamics. This represents a significant development and will pave the way to an online press nip application which is monitored and controlled in real time, without detours or interruptions in production.

Thus, nip profiling with Smart® 5.0 allows the intelligent usage of data and provides papermakers with an instrument for the sustainable and continuous improvement of machine efficiency.

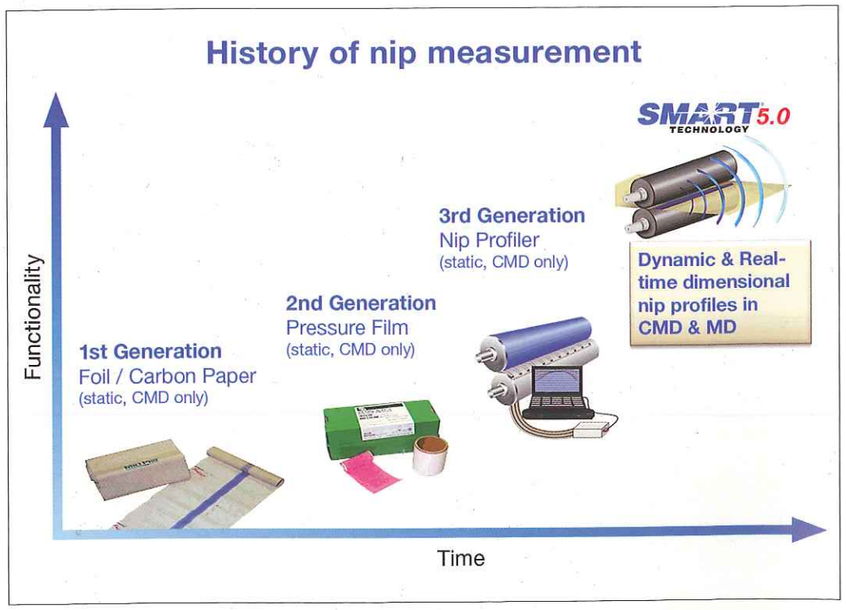

Fig. 1: History of nip measurement

Authors: Stephan Carda, Director of Production at PM 6, UPM Schongau/Germany; Bill Butterfield, Chief Technical Officer (CTO), Xerium Technologies Inc./USA; Andreas Päch, Director of Marketing & Application Engineering Forming Fabrics and Rolls, Xerium Europe/Germany – presented at the IMPS 2013 in Munich

Fig. 2 shows the actual state of an online measured nip (nip impulse) in correlation to the standard deviation of any sensors, which are used to evaluate the nip status. In order to explain the standard deviation: the more the standard deviation of the sensors varies between each measurement interval, the more unstable and more problematic is the behaviour of the press nip.

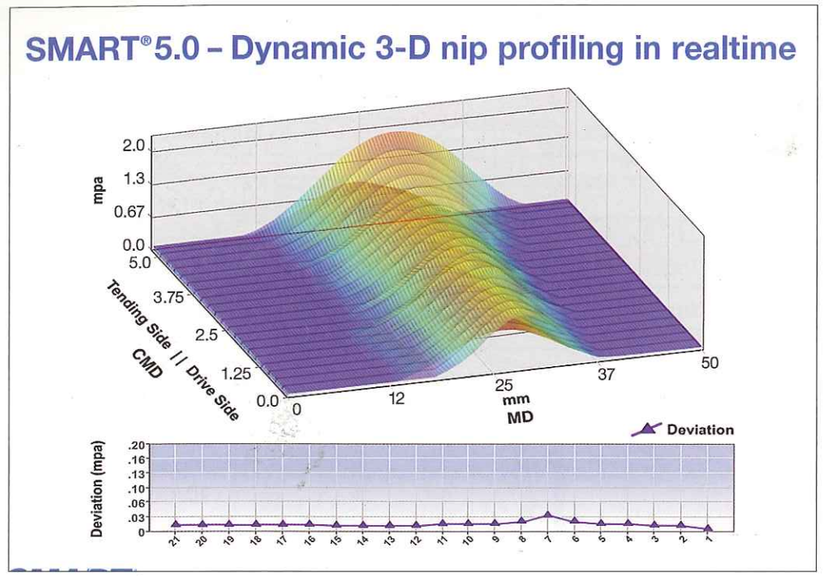

Fig. 2: Dynamic 3D nip profiling in realtime

Paper machine operators have recognized the detrimental effects of cross machine nip pressure profile variations and have used tools such as crowning, unbalanced loading, and crown compensating rolls to improve nip profile uniformity to avoid these detrimental effects. A change in the nip conditions could be generated by changes in the system properties due to wear and/or hardening of the roll cover surface, reduction of cover thickness, varying content of moisture and paper web solids as well.

To make informed decisions and effectively use these profiling tools to compensate for nip variations, the machine operator must first have accurate feedback regarding nip conditions. Embedded sensor systems have been developed to provide the best feedback possible: cross machine, dynamic and real time data.

While the desired cross machine profile maintains quality, the machine direction profile controls pressing effectiveness. The varying machine direction pressure profile between nipped rolls has several characteristics that determine the effectiveness of the nip. One characteristic is the peak pressure. If the peak pressure is too high for a given paper grade or position on a machine, sheet crushing, sheet densification, felt compaction, and other undesirable effects occur.

A second characteristic of the machine direction pressure profile is its nip width. This is an important dewatering parameter for many paper grades. These characteristics are not only important when considered independently, but also the combination of peak pressure and nip width offers additional insights.

An increase in nip pressure is an example of a situation where the combined knowledge is beneficial. By itself, an increase in nip pressure may be difficult to interpret. It may indicate a linear load increase but it could just as easily indicate a stiffness increase in the system composed of the roll cover, felt, and paper mat.

A system modulus increase can occur from events such as cover grinding, cover hardening, felt compaction, and increased paper web fluid content. By simultaneously knowing the peak pressure and nip width, the operator can detect the source of the change and work to accommodate it.

Great potential for optimization with shoe presses

Shoe press nips also have opportunities for optimization. While the shoe press nip width is defined, the machine direction profile may vary and affect performance. Unlike the nearly symmetrical shape of a roll pressure pulse, the shoe press profile is asymmetrical and may contain multiple localized pressure peaks.

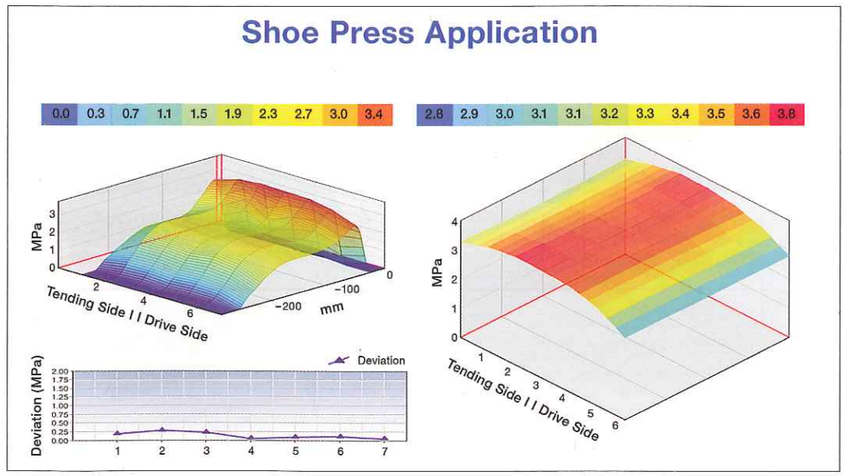

Fig. 3: Shoe press application

An incorrect roll diameter or felt caliper may lead to these inefficiencies. Some shoe presses have the capability to control the pressure ramp rate and machine direction location of the peak pressure. Embedded sensor systems have been developed for shoe press mating rolls to identify these inefficiencies.

Fig 3 shows an online measured nip impulse and peak pressure curve of a shoe press installation, including the sensors standard deviation.

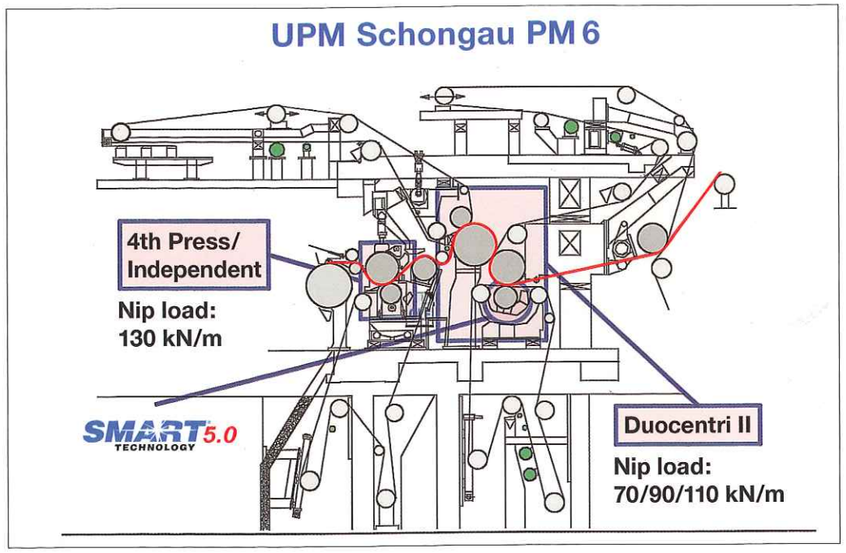

Fig. 4: UPM Schongau PM6

Best experiences on PM6 at UPM Schongau

Benefiting from the many years of cooperation between Xerium and UPM Schongau, the latest version of Smart® 5.0 was subjected to extensive practical tests on the PM6. The Smart® 4.0 which operated for a long time in the 1st press, was upgraded to the Smart® 5.0 system. *Fig. 4* shows the press section setting schematically and the position of the Smart® 5.0 system.

During a period of several months, nip pressure, nip width and nip impulse were consistently recorded by the Smart® 5.0 system.

Steady changing process conditions (for example, pressure differences after start- up from shuts including changes of RC and/or PMC, edge overloading, unevenly distribution of nip load, etc.) were observed. The direct insight into the press nip conditions enables valuable conclusions to be drawn for research into causes and subsequent possible corrective measures.

These could lead to adjustments of inner pressure on the 1st press roll or to release pressure at the roll cover edges, immediately after start-up from shuts as well as other corrective measures.

Examples

1. Start-up after PM-shut with change of pickup and bottom felt

Fig. 5 shows a sectional enlargement in a period of several days, out of the long term nip pressure measurement phase. It shows the measured nip pressure prior to the PM downtime and its changed condition after the start-up. In order to simplify the picture the actual period of downtime was filtered out. Clearly observable is an immediate edge overloading on tender and drive side (green areas = increased pressure level), which reduced proportionally during the braking- inn period of the felts.

The press concept shows in some cases paper guiding problems, particularly at the pickup felt edges within the duration time of the felts. This is noticeable in an increased number of edge cracks and/or amount of breaks. Additional information regarding edge overloads especially in the start-up phase after shuts enables to introduce targeted corrective measures, which could contribute to an accelerated troubleshooting process.

2. Starting up after downtime with a change of PMC and double suction press roll

Fig. 6 shows a sectional enlargement in a period of several days, here with the example of nip width. It also shows the measured nip width prior to the PM downtime with a change of the bottom and pickup felt together with the double suction press roll. In order to simplify the picture the actual period of downtime was filtered out. Observable is a minor change in the measured nip width after start-up of the paper machine from a shut, despite the fact that there was a change of PMC and RC at the same time. Where is the origin?

After the breaking-in period of the felts, the nip width was significantly reduced as well as a slightly overloading effect on tender and drive side was observable again (the more red, the lower the nip width). Through the change of the double suction press roll, the nip is decreased by approximately 2.5 mm / approximately 10 % of the prior nip width. The origin of that could be differing cover hardness or a changed diameter of the installed spare part roll cover.

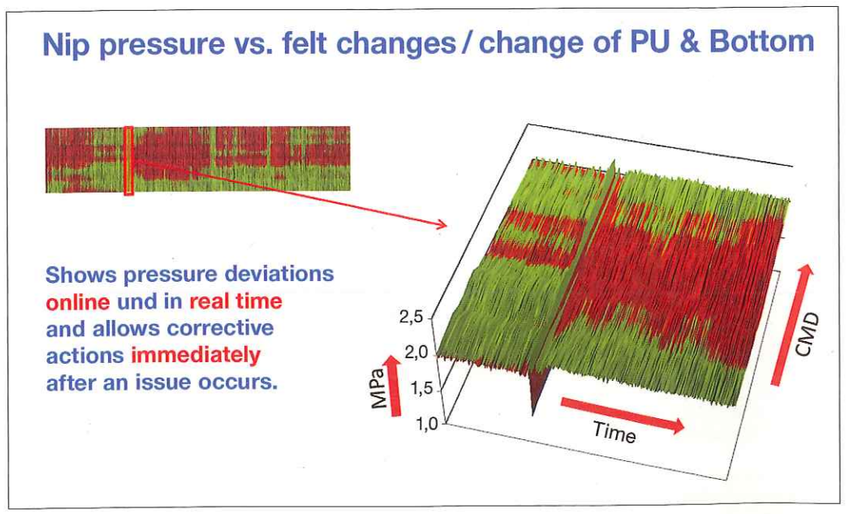

Fig. 5: Nip pressure vs. felt changes

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>
> Stephan Carda, Director of Production at PM6, UPM Schongau/Germany

As a standalone effect this must not have any negative influence to the runability or productivity, however if there is any negative influence noticeable, the Smart® system can provide valuable information and especially online measurement data, which has not been available in this form in the past. This again leads to an accelerated trouble shooting process.

Providing this additional and targeted information or measurement data through Smart® 5.0 leads to precise analysis of results, which – regarding the productivity and efficiency of the paper machine – leads to fast decisions. Stephan Carda, production manager of PM6 at UPM Schongau, summed up the initial experiences with the new 3D nip profiling: "We are satisfied with the Smart System on the PM6. It provides us with additional information to speed up our troubleshooting. In order to support further quality and efficiency improvements we are interested and we want to invest in usage of Smart in further positions."

For example, quality improvements at the 3rd and 4th press and/or the calendar are conceivable here. Generally, in addition to the press section, the Smart® roll technology is also suitable for nip analysis with couch press rolls, soft & multi nip calendars or super-calendars along with the size press (speed sizer) or in lamination and finishing applications. At the end of the year, Xerium had already sold more than 330 Smart® Roll applications around the world for a wide variety of roll and paper machine types.

Summary

Each grade of paper produced has an individual pressing environment in which an optimized peak pressure range has been established. Knowing this range of optimized peak pressures the Smart® 5.0 system can be utilized as a practical engineering tool to ensure the press section continues to operate within this designed peak pressure range. In the past, prior to the invention of Smart technology, this was only possible through analytical modeling based on inputs from the roll cover, clothing, and machine parameters.

With Smart® 5.0 the papermaker will be able to determine, in real time under dynamic operating conditions, whether the press nip is performing at peak optimization levels, by observing the peak pressure output range as a function of nip width. This paper describes a breakthrough embedded sensor system with the ability to measure the nip width of a roll cover, which to date has not been accomplished. This is a significant breakthrough in dynamic nip measurement because it paves the way for real time engineered nip solutions. This information is utilized to engineer a press nip through the use of a mathematical model based upon nip width, pressure, and application experience.

While previous state-of-the-art embedded systems provided the ability to embed sensors in every roll cover material and application throughout the paper machine, the newest generation now allows intelligent usage of machine direction nip width data, which leads to the ability to optimize the press section for sustainable, continuous paper machine efficiency.

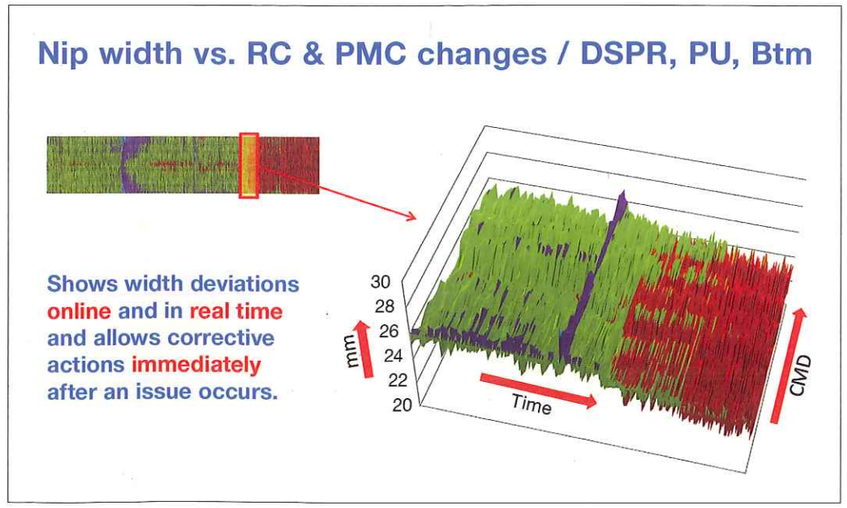

Fig. 6: Nip width vs. RC & PMC changes